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On the Causative Factors Responsible for the Change in the Bison Range

by

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In the Pleistocene, there took place repeated migrations of mammals from Asia to North America across the Bering Isthmus which appeared several times. The fact of the repeated appearance and disappearance of the Isthmus is well validated recently by the distribution of terrestrial foraminifera (Saidova, 1960; Saidova and Lisitsin, 1960). Study of foraminifera from terrestrial deposits in the Bering Sea indicates that in the course of the Quaternary there occurred more than once a rising and lowering of the bottom in this district.

According to the data obtained by K. M. Saidova the strongest rise in the bottom of the Bering Sea corresponded with the Riss when the depth of the continental shallows was significantly less than in contemporary times, on the average 200 m. During the Riss - Würm a lowering occurred but the depth then did not exceed the contemporary limits. Later in the Würm another rise occurred but it was less grandios than in the Riss. In the early Holocene a new lowering of the bottom occurred which is apparently continuing even now.

Thus in the time of the Riss rise there was the widest connection of the Asiatic and American continents in the region of the Bering Strait which in places became dry land. The Würm connection was apparently less extensive than the Riss.

About the earliest history of the Bering bridge there are no direct data. However, in the opinion of Saidova, foraminifera from columns in the northwestern part of the Pacific Ocean indicate that a rise of the bottom corresponded to the Mindel epoch which was probably synchronous, as was the following one also, with a rise in the bottom of the Bering Sea. Therefore, we may suppose that in the course

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of the Pleistocene there was a triple origin of the Bering Strait.

As is known, during periods of the regression of the sea with an increased extent of dry land the climate changed apparently in the direction of a fall in temperature (Voyeikov 1902, 1910; Kerner 1933; Brooks 1952). Precisely these moments in the Pleistocene were accompanied also by the greatest ice cover. The time of regression was accompanied by a general fall of temperature both in eastern Siberia and the northern parts of the North American continent. In the period of the greatest regression there took place also the strongest glaciation of Canada (Figure).

When we consider the contemporary fauna of North America, we are struck by the clear double likeness of it to the Palearctic fauna. A certain part of the complement is very similar to, indeed completely identical with, representatives of eastern Siberia, in part even to the subspecific relationship, whereas others are undoubtedly like the Asiatic ones, but differ significantly, in part even above the rank of species.

Let us consider this question in detail. In the light of careful studies it seems that the first group is peculiar to a considerable part of the more northern latitudes of the North American continent -- Alaska and parts of Canada. In contrast to this, the second group, i.e. those that differ more from Asiatic forms, lives mainly in the southern part of North America, and the ranges of its component species embrace either the territories of southern Canada and U.S.A. or regions of the Rocky Mountains to the south of Alaska. Let us examine the composition of these two groupings. To the southern may be attributed: _Bison bison_, _Ovis canadensis_, _Oreamnos montanus_, _Ursus horribilus_, _U. americanus_, _Taxidea taxus_, skunks, _Canis latrans_, _Vulpes velox_, _V. macrotis_, _Lynx rufus_ and certain others. Into the composition of the northern group enters: _Ovis nivicola_ (= _O. dalli_), _Ovibos moschatus_, _Bison bison athabascae_, Saiga (extinct in Alaska at the beginning of the Holocene), _Alces alces_, _Cervus elaphus_ (= _C. canadensis_), _Ursus arctos_ (brown bear of North America = _U._

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middendorfi, *U. gigas* and others)[1], *Martes americana*, *Mustela nivalis* (= *M. rixosa*), *M. erminea*, *Gulo gulo* (= *G. luscus*), *Lynx lynx* (= *L. canadensis*), *Lepus timidus* (= *L. arcticus*),[2] *Dicrostonyx*, *Lemmus*, *Microtus oeconomus* and many other voles, flying squirrels and others.

Such a phenomenon which seems strange at first sight, becomes clear only after examination of the history of glaciation in North America and northeastern Siberia. In northeastern Siberia, there were only local alpine, but no continuous glaciers and there remained vast territories in which very different mammals, including the wisent, were able to live. In contrast to this, very large spaces were subjected to glaciation in North America. In the epoch of maximal glaciation, all of Canada was occupied for a long period by continuous (continental) glaciers which made it intolerable for the life of the majority of the mammals (Flint, 1947).

As a result of this, those Asiatic representatives which migrated into North America before the glaciation were cut off and lost any connection with their original homeland. Furthermore, they were driven back to the south into the territory of the present U. S. A. and found themselves in absolutely new conditions, different from the northern landscape. This was the cause of their quick change and acquisition of specific adaptation to the new conditions. After the retreat and disappearance of the ice on Canadian territory, a new migration across the Bering Isthmus took place. Many Asiatic mammals mentioned earlier invaded North America anew.

The history of the bison in North America serves as a beautiful illustration of these events.

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[1] The systematics of American bears was brought to its present chaos by Merriam (1918) who divided them into several tens of species (!) and more than 100 (!) subspecies. In reality, there actually exist in North America: grizzlies (*U. horribilis*) with several races (U.S.A. and B.C.); brown bears (*U. arctos*) apparently identical with bears of extreme northeastern Asia (Alaska and northern Canada) and black bears "baribal" (*U. americanus*).

[2] *Lepus timidus* is more likely the equivalent of *L. americanus*, the snowshoe or varying hare (translator).

The classification of the Bison which Skinner and Kaisen (1947) gave does not, in our opinion, correspond to reality. It would appear to be completely impossible that such a large number of subspecies and species of bison existed. It would not be possible that two or especially several morphologically and ecologically very similar species of bison could live together and not interbreed. Study of the skulls of fossil bison of Europe and Asia does not give a basis for the division of the genus Bison into a large number of forms. Bison have very great variability, especially in the form and length of the horn, yet almost all "subspecies" and "species" of fossil bison are distinguished exactly according to basic differences in the form of the horn. Still less probable is the possibility of simultaneous migration of herds of similar species across Beringia to America.

It is more correct to suppose that in the early Pleistocene a long-horned type of Bison arose (Bison cesaris = B. priscus = B. alleni and possibly B. latifrons). This long-horned type penetrated to North America from Asia at the end of the Yarmouth (Mindel-Riss)[3] and beginning of the Illinoian (Riss). This was the first migration[4] and descendants of it -- B. antiquus -- lived on the territory of the U. S. A. in late Pleistocene.

According to the data gathered by Skinner and Kaisen which is shown on their maps, bison lived in Alaska, the United States to the south as far as Mexico in the middle and upper Pleistocene. In Canada and the northern States (Washington, Oregon,

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[3] The correlation of European and American Pleistocene deposits cannot be considered satisfactory at the present time. It is more or less established that the Wisconsin corresponds to the Upper part of the Würm but the comparison of the Riss and the Illinoian is not fully proved. In our opinion, there are better grounds for applying the American stratigraphic scheme to northeastern Asia than there are for the European scheme at the present time. For a series of cases the American scheme fully corresponds to those faunistic events which occurred both on dry land and in the seas of northeastern Asia in the Pleistocene.

[4] Absolutely improbable, incomprehensible and undoubtedly erroneous is the assertion of C. W. Hibbard (1958) that Bison and the basic mass of other Asiatic migrants first appeared in America only in the Wisconsin. Such a supposition is contrary to all available data.

Montana, Dakota, Minnesota, Wisconsin, northern parts of Ohio and Virginia and the northeastern States) bison were not able to live at that time because all of this territory was covered with glaciers.

In northern Asia, in Beringia, and in Alaska bisons (B. priscus longicornus = B. preoccidentalis = B. crassicornis and others) lived during the epoch of the Wisconsin (= Würm) glaciation, since these territories were not completely covered by ice. In these territories also there arose a new short-horned type of bison (B. occidentalis = B. priscus diminutus = B. bison athabascae and others). After the retreat of the glacier in Canada, bison pushed further to the south in America (second migration): in the latest Pleistocene and early Holocene they occurred in a broad belt from Alaska in the northwest to Texas in the southeast and partially overlapped the range of the descendants of the southern Pleistocene bisons (B. antiquus) of the first migration.

In these regions a mixing of both populations occurred and from this mixture arose the plains bison -- B. bison bison. In the north, on the other hand, the wood bison (B. bison athabascae) remained in pure form as descendants of the late Pleistocene migrants.

The plains bison (B. bison bison) which are adapted to the distinctive conditions of the prairie lost the traits of their ancestors to a considerable degree. In them, the pelage, coloration and even the whole exterior was changed. All the features of their ecology were also changed.

We see absolutely the reverse in the American wood bison (B. bison athabascae). It is necessary to notice that from 1925 to 1928, in spite of the protests of many scientists (F. Harper, W. Rowan, H. E. Anthony and others), 6673 plains bison from Wainwright National Park in Alberta were introduced into Wood Buffalo National Park where more than 2,000 wood bison existed (Garretson, 1923).[5] The wood bison would

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[5] The total number of bison in Wood Buffalo National Park today has grown to 40,000 head (sic) and they are used as a food reserve for the settlements -- controlled shooting is permitted (Colin 1955).

have disappeared as a separate form if it had not been for a happy accident. In a letter of October, 1959, A. F. Oeming, Director of the Alberta Game Farm at Edmonton, Canada, reported to us: "At present, one can be quite sure that a small herd of pure-blooded wood bison has come to life again in the far northwestern corner of Wood Buffalo National Park. I spoke to Ward Stevens, Chief mammalogist for Canada and he confirmed this. Because of their geographical isolation, these animals did not mix luckily with the introduced plains bison". This information was confirmed also by Banfield of the National Museum of Canada who sent us clear photographs of bison obtained from Buffalo Lake in February, 1959, which were studied by him and definitely determined to be genuine B. bison athabascae. Besides this small number of wood bison, there are several examples obtained from 1925 and contained in the collections of the National Museum of Canada and certain other institutions. In 1925 Rowan (1929) visited Wood Buffalo National Park for the specific purpose of studying these animals and he made excellent drawings and descriptions. In 1958 after Rowan's death, we were able to obtain photographs of Rowan's pictures and also copies of his notes, thanks to the courtesy of his widow (Rita G. M. Rowan) and L. A. Bayrock of the University of Alberta.

A single, careful study of these pictures indicates that the wood bison as was assumed by certain American zoologists (Seton, 1927) stands closer to the European wisent in a number of features than it does to typical plains bison and occupies an intermediate place between them. The structure of the skull, form of the horns, character of the pelage, and the coloration rather confirm this (Rhoads, 1897; Allen, 1900; McFarlane, 1905; Garretson, 1923, 1938; Skinner and Kaisen, 1947; written reports of Banfield, Oeming, photographs of an assemblage of wood bison in the National Museum of Canada, and examples which belong to Brintnell[6]).

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[6] We are very grateful to L. Brintnell of Edmonton for placing at our disposal black and white and colored photographs belonging to him of the head of a wood bison taken in the very early 1920's.

A highly significant and characteristic feature remains to be noted. In uite a number of animals which are found at present in Wood Buffalo National Park here are features peculiar to hybrids between bison and wisent. G. G. Goodwin[7] f the American Museum of Natural History in New York kindly sent us photographs hich he got at the time of his journey to the Athabasca in Wood Buffalo Park in 934-35 which depict animals resembling bison-wisents[8].

Craniologically *B. bison athabascae* is very similar to late Pleistocene and arly Holocene *B. occidentalis* from which it differs only in its smaller size. Since *. occidentalis* is similar to late bison of northeastern Siberia, then it is to us completely established fact that the wood bison *B. bison athabascae* represents a orm near to its Asiatic ancestor and is its living representative in America.

Asiatic and American late Pleistocene and Holocene wisents were apparently identical and can be united in one form. European wisents (*B. bonasus*) took their origin from the same ancestor as *B. bison athabascae* but changed more strongly.

In prehistoric and historic times, *B. bison athabascae* reduced its range which was restricted to Alaska, Western Canada and the Rocky Mountains to the state of Colorado in the south. However, assignment of the bison which lived in the southern part of the region of distribution, in the limits of the United States, to the subspecies *B. b. athabascae* is not fully demonstrated. However, it is highly probable that this form of wood buffalo was actually able to penetrate far to the south in the mountain forests as Skinner and Kaisen assumed. The wood bison did not mix with the plains (bison) owing to geographic isolation.

In historic times *B. bison athabascae* gradually retreated from Alaska and the Rocky Mountains and remained only in the region of Great Slave Lake. As for the plains bison which were adapted to life in open places, their range was confined

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[7] Part of Goodwin's photographs were published in his articles (1935, 1936, 1937).

[8] For sending the photographs we express our sincere thanks to Goodwin.

only to the prairies of North America.

In northeastern Siberia the latest bison in a fossil state that is known at the present time is attributed to the end of the Pleistocene or perhaps to the earliest Holocene. Skulls of these bison resemble contemporary wisents and all are short-horned. The remains of a wisent from permanently frozen ground in eastern Siberia which is housed in the Zoological Institute of the Academy of Science of the U.S.S.R. in Leningrad, shows that the last of those animals to live did not differ in size from contemporaries in Beloviezha. The hind leg of a wisent, lacking femur and phalanges, with skin and part of the hair, found on the lower reaches of the Yana River near the village of Kazach', belongs to an example no larger than the average of contemporary wisents. According to its characteristics it is undoubtedly the extremity of a bison but not an animal of the type of the American wood bison. Exactly the same is the story of another extremity found in 1946 by Yu N. Popov on the banks of the Struyk Creek in the valley of the El'g River, a left tributary of the Indigirka River (Popov, 1947-1948). All of the distal part (with the exception of the lateral digit) including the skin, the hairy covering, and the horny cover of the hoof, was completely preserved. This is probably the front limb of an adult, or even an old, female of small size. The length of the sole of the foot is 98 mm, the greatest width 45 mm. The hoof is cylindrical in cross section and with wrinkled growth as occurs only in adult wisents but not smooth as in young ones. The color is black. Hooves are relatively strongly bent in the form of a crescent as is always strongly expressed on the forefoot; hind hooves are straighter. The hooves are comparatively short and strongly abraded, resembling more the hooves of the Caucasian wisent. The pelage, which is beautifully preserved, consists of thick, long guard hairs (about 33-35 mm long) and delicate curly underwool. The long and thick hair suggests that this is the winter pelage but the strongly matted guard hairs and their coloration suggest that the animals died in late winter or even early spring when the pelage was already worn. The coloration is a light

gray-brown somewhat lightened from its prolonged sojourn in permafrost. However, all types of coloration are entirely similar to the coloration of wisents and only a little lighter than the spring pelage of the contemporary ones. The length of the hair may be a little longer than in our wisent which is probably connected with the more severe conditions of eastern Siberia. It is apparent the animals lived in the earliest Holocene and therefore we may consider them to be one of the latest representatives of the wisent in eastern Siberia. They are precisely wisents and were the nearest relatives of the wood bison.

Taber (1943) determined the stratigraphic position of the silty deposits of the Yukon Plateau and the Seward Peninsula which are typical of all of glaciated Alaska with the exception of small regions. He described a schematic section of the Quaternary deposits of the above-mentioned districts. Bones of bison are found in the fourth and fifth layers (from the bottom). The fourth layer contains weakly rounded gravels and pebbles with a mixture of sands and crushed rock without any sign of sorting which are petrographically related to the underlying basic rocks of the Mesozoic; average thickness 10-12 m. The fifth layer is dark gray silts almost black, sometimes dark brown with seams of peat which includes strong layers, seams, lenses, and veins of buried ice. Both layers contain in abundance the bones of mammoths, bison, horses and other mammals.

On the basis of the environmental indications and the discoveries of fossil fauna and flora, Taber considered that the time of deposition of the gravels corresponded to a dry, moderately cold climate whereas the time of the silts was more humid with glaciation of adjoining uplands.

Traces of Folscomb man, who lived 15-00,000 years ago, found in frozen silt together with bones of mammoth on which the muscles remained, testify to the fact that bison lived here at the end of the Pleistocene and probably in the early Holocene.

We see that in Asia and in North America bison became extinct at the beginning

of the Holocene. Apparently in the present case we have a picture analogous to the distribution of musk-ox. Musk-oxen became extinct in all the palearctic territory and remained in North America and Greenland, i.e. in those places where climatic and topographic conditions existed that were connected with the presence of continental ice at least in nearby regions. Even in North America musk-oxen gradually retreated with the ice from the west bank of the MacKenzie River and withdrew to the east closer to the glaciated territory. With the retreat of the glaciers and the warming up of Europe and northern Asia and the changing of the vegetation, the musk-oxen also retreated.

As the musk-oxen gradually retreated to the east, so also the wood bison, reducing its own range, found its last refuge in the forest territory of Great Slave Lake.

How, then, is it possible to explain this extinction over a wide territory of Siberia and North America?

Many consider that one of the basic causes of the extinction of large Pleistocene mammals was the destructive activity of Man. Undoubtedly that was great, especially in the last 1,000 years, but certainly not so great that it should noticeably reduce the numbers of such animals as the mammoth, wooly rhinoceros, cave bear and ice bear in the paleolithic and neolithic epochs. Many say that in Africa the population was scanty and therefore elephants and rhinos remained there. Apparently, in southern Asia , India and Indochina there must have been a very sparse population since there, even in our day, both elephants and rhinos and many other large mammals live. But you see in these places we know of many relics of material cultures which were established more than 2,000 years ago. Who, then, established them -- the scarce population that was found in the wilderness stage?

Then also the population of Siberia was much more dense than in India since there the mammoth and rhino and bison were destroyed.

How do the supporters of anthropological factors for the extinction of large animals represent the population density of Europe, the Verkhoyansk District, Taimyr and western Siberia in the last 2-3,000 years? Probably Europe in their opinion had a very small population, in the present instance significantly scarcer than the above-mentioned parts of Siberia, since it was just in Europe that the large horned deer (i.e. Irish elk) and the aurochs remained longest of all and until recent times the bison lived, whereas through all of Siberia those beasts were destroyed by man. It is necessary to consider that such an interpretation of anthropological factors in scarcely correct. It is known to everyone that the bison in North America flourished right up to the construction of the (Northern) Pacific Rainroad in spite of the fact that Indians always hunted them. But after construction of the railroad, Americans, in the course of ten years, shot with "Remingtons" all the millions of head of bison. The same must be said about elephants, rhinoceros and zebras in Africa where they were killed by the Boers. Mankind, not only in the Paleolithic and Neolithic but even in the Bronze Age, was entirely incapable of completely destroying masses of large beasts.

Let us examine now which are the actual causes of the extinction of Pleistocene mammals. We know that moose in western Siberia do not live in all the regions of deep snow and the northern boundary of their distribution beyond the Urals is lowered sharply to the south along the Ob' right up to the farthest south outskirts of the forest zone. But it goes farther to the north again in Transyenisey where the snow cover is much less.

In post-glacial times there was a period of warming and the snow cover was significantly weaker both in Siberia and in the European part of the Union. Exactly at that time red deer were widely distributed through the Central Russian Plain, but afterwards when the next cooling off and increased snow cover began, they left there.

American forest bison live under very severe conditions at Athabasca and

reat Slave Lakes. The latter remain ice-covered for seven months. Frosts attain 54°. The mean temperature in January is about -24°. Winter begins in the middle f October and drags on until the end of April.

However, all of this does not normally prevent the existence of bison. hat is the cause of this? It appears that the snow cover in the habitat of the ison on the Athabasca on the average does not exceed half a meter. Permafrost is ound sometimes at a depth of 10 cm. On the European plain there is no permafrost ut the snow cover is stronger and the wisents retreated therefore to the west and outh and to less snowy districts. American bison in the winter can be satisfied ith snow alone and manage entirely without water. Wisents, on the contrary, re-uire drinking water.

In the steps of Transbaikalia, Manchuria and Mongolia, there is often no now at all in winter and even the bison would not have found it there in sufficient mounts. All these facts undoubtedly created unfavorable conditions for wisents in astern Siberia. The greatest depth of snow cover is peculiar to western Siberia nd Alaska as is known.

Both wisents and forest bison absolutely require food of leaves and twigs into the composition of which many deciduous types enter: willow, aspen, oak, linden, mountain ash and others. Moreover, neither of these animals is able to anage without definite species of grassy foods which are completely absent from northern Siberia and Alaska. Both avoid extensive sphagnum bogs and the plant associations connected with them, the very thing that is extremely widely distributed in Siberia.

According to the data of pollen analysis gathered by R. E. Giterman (section of Paleobotany, Geological Institute, Academy of Science U.S.S.R.) it is clearly evident that the specific composition of arboreal vegetation changed very little during the Pleistocene in northeastern Siberia. A clear change in the specific composition and chiefly in the quantitative presence of pollen of arboreal types is

bserved at the boundary between the Pleistocene and the Holocene. In the Holocene he percentage of pollen of coniferous types is clearly increased so that it may be upposed that coniferous forests occupied significant spaces and advanced farther o the north. The composition of these forests wes similar to the contemporary ones: *arix* and *Pinus* predominated and among deciduous types there were present only *Alnus* nd in very small amounts *Betula* (both tree-like and shrubby).

It is necessary to note that birch was abundantly represented in the Pleistoene and was reduced in the Holocene, occupying a very small place in the percentage omposition of the pollen in comparison with what it was in the Pleistocene. In the leistocene, arboreal forms of *Betula* composed up to 38 per cent and shrubby forms - per cent; in the Holocene the first was reduced to 7 per cent, the second to 5 per ent. Alder, which was found in large amount in the Pleistocene (up to 48 per cent), as increased in the Holocene and attained 79 per cent. Aspen and poplar, because the pollen is not preserved, is completely absent from all analysis.

Herbaceous vegetation underwent a very clear shift at the border of the Pleistocene and Holocene in northeastern Siberia. In the upper Pleistocene it was represented by numerous families; Gramineae, Compositae, Cruciferae, Caryophyllaceae, Chenopodiaceae, Ranunculaceae, Polygonaceae, Rubiaceae and others. *Artemisia* was found in large numbers (15 per cent) and a little *Myriophyllum* (2 per cent).

Almost all of these plants were completely absent in the Holocene or were represented by a few individual specimens of pollen. For example, *Artemisia* is in no more than four specimens. Caryophyllaceae also in no more than four and cereals in no more than 23 specimens. The rest of the families enumerated are not found in the Holocene. But to make up for it there was, in significantly large numbers, Onagraceae and Ericaceae which were known in the Pleistocene in insignificant amounts.

The analyses done by A. P. Vas'covski (1957, 1958a and b) give a completely analagous picture. Pollen analysis of loam from the cranial cavity of a bison (*Bison priscus longicornis*) indicated a complete absence of the pollen of conifers:

ruce, larch, and pines of the *Diploxylon* type; birches gave 37 per cent, alders per cent, heaths 21 per cent, herbs of various families in insignificant amounts for example *Artemisia* - 12 per cent); spores of sphagnum - 16 per cent. The skull f this bison was found in the big Chukuchannaya River and its age is determined as iss'.

The complete spectra listed by Vas'covski (1957) for extreme northeastern iberia give for the Taiga zone the following indices: larch, 6 per cent, pine of *aploxylon* type - 59 per cent, birch (shrubby and white) 17 per cent, alder - 11 per ent, heaths (Ericaceae) 42 per cent, cereals - 15 per cent. The rest of the herbs, imited in the composition of families, almost entirely represented by individual pecimens. Spores of sphagnums - 28 per cent.

The fact that the increase in Holocene pollen of Ericaceae is in step with n increase in quantity of spores of Sphagnales is very significant.

The cited data indicate that at the boundary between the Upper Pleistocene nd early Holocene, a significant and clear change in the plant cover of Eastern iberia occurred. The quantity of deciduous arboreal vegetation decreased owing to decrease in the numbers of white birch and willow. In their place, conifers rrived. Forests advanced far to the north. Herbaceous plants changed still more learly. A considerable variety of them peculiar to the Pleistocene disappeared ompletely. Only a very limited number of cereals, wormwoods and certain others emained, but there was a strong increase in Ericaceae, Onagraceae and probably osses, that must be attributed to the rise and prevalent distribution of associations of the contemporary sphagnum types (*Laricetum sphagnosum* and others).

It is necessary to think, as B. A. Tikhomirov (1941) quite justly considered, that the penetration of arctic elements into the flora of asiatic Beringia occurred in very late times. These at present still preliminary and fragmentary data confirm the basic thesis concerning a shift in the landscape conditions in eastern Siberia in the early Holocene.

The rise of the new complex of conditions was completely unsuitable for ents. Therefore, it is quite clear that with the cooling off which began after elatively warm period following the disappearance of glaciation, the composition vegetation and the snow regime was changed. The wisent began to reduce its ge sharply, withdrawing into places where a landscape peculiar to them remained. e the red and large-horned deer, they withdrew into places with a lesser snow er. Red deer completely disappeared in northern Asia and in a large part of tern Europe. Large-horned deer even died out completely. Large-horned deer e completely unadapted to deep snow. The huge weight and very small area of port of the hoof did not enable them, in contrast to reindeer, to move through w. In this regard, even moose and moose deer (Cervalces) had a great advantage r them and the wisent since their limbs were relatively longer and enabled them walk as on stilts through comparatively deep, up to 60 cm, snow. Besides the a of support of the hoof was relatively considerably larger than in the large-ned deer and wisents.

In Canada, bison remained in the region of Great Slave Lake. This is how er (1941, p. 367) characterizes conditions in Wood Buffalo Park:

> "In general, the Alberta plateau is characterized by rolling uplands covered with forests abundantly intermixed with open bogs, by stunted bog forests, by prairies and moist, grassy plains. The landscape is extremely varied: bare, sandy uplands on the one hand and cold, dreary bogs on the other. True prairie is commonly found only in small patches surrounded by timber -- seldom more than a few acres, but open marshy swamps represent extensive level spaces."

Since Wood Buffalo Park is situated in a district with a severe climate and a zone of permafrost, the grassy plains and prairies found in its territories are ferent from the southern ones and have a distinctive appearance (coloration). They bably, to a certain degree, represent those peculiar conditions of the cold steppe

d forest steppes which, according to available data, existed in the Pleistocene northeastern Siberia.

Thus, it is necessary to suppose that both in morphological features and in s ecology, the American Wood Bison stands nearest of all to the last wisents of stern Siberia. In contrast to them, the European wisent ought to be characterized a more warm-loving form which is connected in its distribution with certain broad-aved types (oak, linden and maple) and more distinct from its early Holocene cestors.

All that has been said forces us to consider that one of the basic causes of e extinction of the wisent as also of the large-horned deer in eastern Europe, beria and northern North America was the increase of the snow cover and the change vegetation in the beginning of the Holocene.

On the other hand, the extinction of many arctic species (mammoths, hairy inoceros) or the sharp reduction of their range (musk-oxen) was called forth by e changed conditions combined with the disappearance of the glaciers and the warm-g up.

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